Charles Arthur Lovatt Evans, 1884-1968

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CHARLES ARTHUR LOVATT EVANS
1884-1968

Elected F.R.S. 1925

Charles Lovatt Evans, Emeritus Professor of Physiology, University of London, and a former Vice-President of the Royal Society, died on 29 August 1968, at the age of 84, at his home at Winterslow, near Salisbury. He was the foremost pupil and a lifelong associate of E. H. Starling, Jodrell Professor of Physiology at University College London, and eventually occupied the same chair.

Lovatt Evans was born in Birmingham and spent the whole of his childhood and early manhood there. His father Charles Evans taught music—piano and violin—and was a man of many interests, of which ancient history was one, and he started to learn Greek when in his sixties. Although a humorist he had somewhat rigid views on religion, life and death, and held the view that the more you do for people the less they do for themselves, so Lovatt Evans was largely left to himself to decide upon his future and surmount the difficulties of finding ways and means. His mother seemed to him to be of rather an aloof nature, spending much of her time in intellectual pursuits often at the expense of her domestic duties. The result was that in his home life he was lonely.

Early years and education

Lovatt Evans’s early education was at the Birmingham Upper High Street Elementary School and the Council Secondary School (Waverley Road) where he joined the science side; he was then 13 years of age and had already decided upon a scientific career. The schools in Birmingham were too small for each to have a chemistry master, so one master used to visit each school once a week. It was the central event of the week for Lovatt Evans, for this master used to do experiments—‘wizardry’. Such was his attraction that Lovatt Evans left school at 14 and spent a year travelling round with him as technical assistant before realizing that he must have further conventional education. This he achieved by taking correspondence courses, by studying at the Birmingham Municipal Technical School and, at the age of 16, by starting work in the Department of Physiology in Mason Science College, Edmund Street, Birmingham, under Professor Wace Carlier. His father, not infrequently, showed his appreciation of his successes by gifts after an examination had been passed. In this way Lovatt Evans collected a chemistry
set, which included a large retort of which he was inordinately proud, a chemical balance and a sink fitted with gas and water which enabled him to carry out experiments in his room adapted for the purpose at home. The experiments were varied and sometimes hazardous. ‘Demonstrating to a cousin the inflammability of hydrogen, the premature application of the match brought to light, and to sound an ancillary property of hydrogen.’ On another occasion, ‘preparing some mixture that was supposed to go off with a bang when it was lit, a friend devoted to physics, tried to accelerate the drying of the mixture by putting it in the kitchen oven. The new range was a great improvement, and the windows were soon reglazed. One difficulty was the supply of distilled water, which strained the resources of the retort, but this was overcome through a friend whose father was engineer at a large paper works, where the condensed steam water was adequate. An obliging aunt with a pony and trap solved the otherwise arduous transport problem.’ Eventually his ‘home studies in chemistry were suspended as the result, first of a preparation of phenyl carbylamine on a needlessly large scale, which revealed defects in some of the local sewers, and second by the unexpected disintegration of a quantity of nitrogen iodide, which was intended for use on February 14th by being inserted in a damp state into some Valentines’. After these episodes, his ‘home activities, at his father’s earnest request, were transferred to the more tranquil study of biology, though even that had its dogfish’.

By the age of 17 (1901) Lovatt Evans had obtained 11 Board of Education Certificates up to honours standard in organic and inorganic chemistry and one (1st class) in advanced human physiology. His promise had been recognized by the award in two successive years of the Butler Prize by the Birmingham Municipal Technical School. The next nine years were occupied in making a living by giving private tuition, lecturing, and preparing himself for matriculation as an external candidate in the University of London with the ultimate aim of taking a degree. He became lecturer in Physiology in Handsworth Technical School (Staffs) (1902-1908), Demonstrator in Physiology at the Birmingham Midland Institute (1904-1907), and Interim Lecturer on Physiology, University of Birmingham (by special permission from the Senatus) (October-December 1908). In 1907 he matriculated as an external candidate, University of London, and was put in charge of certain classes in physiological chemistry, Birmingham University, by special desire of the Professor, and he also took part in the teaching of histology. His notes on physiological chemistry and the histological slides he had prepared were still in use some 20 years later.

His first paper, published in 1903 in collaboration with Professor Carlier, was entitled ‘A chemical study of the hibernating gland of the hedgehog’. In this paper it is stated that the research was carried out ‘with the co-operation of an experienced analytical chemist, Mr C. A. Lovatt Evans, who is mainly responsible for the present communication’. Four other papers, mainly dealing with enzyme action, were published before graduation—a remarkable record.
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Despite these arduous days he enjoyed nostalgic memories of his life in this city of his boyhood—'lit by a crude coal gas, rich in sulphur compounds, and burnt in fish-tail burners: later with incandescent mantles as the dernier cri: electric light was just coming in'. Transport was practically all horse-drawn, even to some of the tramways. 'But the city with its motto of "Forward", also had steam trams, of which it was no doubt proud. When later, in World War I, I became involved in defensive measures against chemical warfare, I often wondered whether my interest in the asphyxiating gases might not have been attributed less to my studies in chemistry than to the fact that I used to travel on the top deck of these trams, fired by coke and pyrites, and belching forth, to the accompaniment of dreadful clangour, not only showers of sparks but volumes of carbon monoxide and sulphur dioxide enough to gas a brigade.' His interest in and affection for Birmingham University and the Medical School was maintained throughout his life. Having retired from the Physiology Department as Head Steward in 1910, he was external examiner in physiology in the late 1920s, was invited to propose the toast of the University of Birmingham at the 6th Annual Dinner on Founder's Day in 1930 and to give the Opening Address of the Birmingham Medical School in 1948, and was awarded the LL.D. by the University in 1934.

University College London, 1911-1916

When in 1910 he sat, as an external candidate, for the London B.Sc. examination he was 26 years old and had had some experience in lecturing and demonstrating in chemistry practical classes. At that time his one ambition was to make a career in chemistry, but this was not to be. On Saturday, 12 November of that year, the practical examination in physiology was completed at University College. In the first Bayliss-Starling lecture which Lovatt Evans gave in 1963 he stated what happened: 'At the close of the examination the external examiner, Professor Francis Gotch recalled that he had examined me 5 years previously at Oxford for the Board of Education Honours examination in physiology, and he asked me now to stay behind, as Professor Starling wished to talk to me. This he did, and, after the interview he deputed Dr Aders Plimmer to show me round the laboratories, then quite new, and I was introduced by him to members of the staff, including Dr W. M. Bayliss. I was quite overcome by the natural friendliness of all these well-known people, and returned home all agog with the exciting experience. Five days later I received from Starling the offer of the post of Sharpey Scholar, at the salary of £150 per annum, with his sanction to do a limited amount of coaching after 5.00 p.m., and as soon as I had learned the names of former holders of the Scholarship, beginning with that of E. A. Schafer, I accepted promptly.' He took up the appointment in January 1911, and in the same year became a member of the Physiological Society and joined the newly-formed Biochemical Society, about which he left the following note.

'I well remember the Foundation meeting on Jan 21st 1911, at U.C.L.,
before the meeting of the Physiological Society at King’s College; J. A. Gardner (John Adipose to his friends) sitting on the lecture bench, and swinging his legs as he outlined the projected Society. H. E. Armstrong was insistent that it be called a club, and that a dinner be an important constituent of its meetings. I also attended the Inaugural meeting at U.C.L. on March 4th, at 4.00 p.m., followed by dinner at Blanchard’s Restaurant at 7. Plimmer was appointed Secretary and Treasurer, and to him I paid, in his laboratory after the meeting, the first member’s subscription to be paid. At this time, all the members knew one another, the meetings were informal, and on the lines of those of the Physiological Society. It is a fact that Biochemistry had largely been nurtured by the Physiologists, and was thought little of by the Chemists, since it had to deal with colloidal messes to which current chemical techniques were not readily applicable. The work of Emil Fischer, however, had given reason to believe that before long Organic Chemistry would go full circle, and become again interested in its biological significance as contrasted with the enlargement of Beilstein. Further, the growing significance of Physical and Colloid Chemistry was an important factor in the Biological Sciences, and has, in fact led to some of the most important advances in the techniques of Biochemistry in quite recent years. The visit to the Rothamsted Experimental Station on June 10th, 1911, was an especially memorable one, as we were shown, among other things, the experimental plots, and the platinum dishes, about the size of shovels, in which Lawes and Gilbert ashed their pigs in their classical experiment.‘It was unfortunate that, at the first annual meeting, which was held at U.C.L., during the business meeting after dinner there was a squabble about the composition of the Committee, as a sequel to which H. E. Armstrong resigned his membership of the Club and banged out of the room. This was unfortunate, as he did so much to help start the Club.’

In the first Bayliss-Starling Memorial Lecture Lovatt Evans gave a vivid description of the scientific and social life of those in the Physiology Department. Starling, Bayliss, Buckmaster, Ruth Skelton and Lovatt Evans were in Physiology, which included histology, and Aders Plimmer and Page in Physiological Chemistry. Starling sent him to Freiburg University in Germany for a few months in 1912 where he made many friends, and later arranged for him to study medicine at University College Hospital. During the five years he was in the laboratory he was mainly engaged with Starling in studies of the metabolic processes of the heart and lungs, in which he never lost interest and continued when later he himself occupied the Jodrell chair.

FIRST WORLD WAR

After qualification (M.R.C.S., L.R.C.P.) in January 1916 Lovatt Evans joined the R.A.M.C. and was seconded to work at the Royal Army Medical College at Millbank where Starling, with the rank of Major, was in charge of the Anti-gas Department. There they studied arsine, phosgene, hydrocyanic acid and mustard gas, the last named at the suggestion of Harold W. Dudley,
and Starling advised its use, but it was rejected. Lovatt Evans recalled that 'when, some 15 months later mustard gas was used by the Germans Starling was infuriated, and made a vigorous protest at the highest level; the result of this was that he was promoted to Lt.-Col., and sent to Salonika as Army Chemical Adviser, with nothing particular to do. He did it very well, and was awarded a C.M.G., . . . ' Later, Evans was transferred to Aldershot Command H.Q. and became Command Chemical Adviser with the rank of Major. His main duty was the supervision of anti-gas training throughout the Command. Captain H. D. Kay, one of his officers, who had had experience of gas attacks in France, was in charge of the Aldershot Command Gas School where a large number of British, and later, American officers of all ranks were trained. He remembers that: 'At the Command Gas School just outside Aldershot the training was pretty realistic, and our night gas-attacks in Long Valley, which Evans attended from time to time, kept the G.O.C. (Sir Archibald Murray) who lived about two miles away, awake. He complained to Evans who, I understand, pointed out to him that night gas-attacks did occur overseas, sometimes following bombardment and that this noisy training was essential. Subsequently, however, we did this kind of training earlier in the evening!' . . . 'Evans was an excellent Commanding Officer—not too commanding, thoughtful, friendly, full of ideas, quite unflappable in presence of the highest brass—and we did get consignments of quite lofty brass from the British and other armed forces, of politicians, and even of assorted royalty at the Gas School. He was, in fact, a trifle impatient with bombast.'  

Apart from anti-gas training, Lovatt Evans and Kay investigated the efficiency of respirators, both British and foreign, and the means for gas protection for houses. They also studied the CO₂ and O₂ content of the air in crowded gas-proof dug-outs—this with Leonard Hill—Evans and Kay and the Gas School staff acting as CO₂ producers.

Field trials were sometimes held on the then empty land of the Chemical Defence Experimental Establishment at Porton Down. Late in 1917 Lovatt Evans was staying there 'for about ten days in the mess at Idmiston; during that time King George V came on a visit to Porton, and I well remember a scrum in the mess that night, when I had a rib broken.'  

'Early in 1918, an inter-allied Committee decided that the Italian forces had inadequate gas protection, and Starling was asked to go to Italy to convince the Italians by demonstration that ours was the best (respirator) available and to negotiate transfer of the requisite number of these.' Starling took Lovatt Evans to Italy with him and they were so far successful that before they left 1½ million respirators had been delivered, and fitting begun.

M.R.C. HAMPSTEAD AND
ST BARTHOLOMEW'S HOSPITAL, 1919-1923

On demobilization in 1918 Lovatt Evans accepted the Chair of Physiology and Pharmacology in Leeds and the following year joined the staff of the
National Institute for Medical Research. There his research activities covered the regulation of the reaction of the blood and the effects on the circulation of changes in the carbon dioxide of the blood (with Dr H. H. Dale, later Sir Henry). These studies were epitomized in his first book *Recent advances in physiology* published in 1925, three years after he had moved to the Chair of Physiology at St Bartholomew's Hospital Medical College; the book was an immediate success and later ran into four editions, including two Spanish translations. At Bart's he had succeeded F. A. Bainbridge with whom some eight years previously he had studied renal function in the heart-lung-lung kidney preparation in Starling's laboratory, a preparation which later gave such valuable information in the hands of Verney and Starling. His first task at Bart's was the conversion of Bell and Croyden's warehouse at 6 Giltspur Street into laboratories; the site of the old department behind the west wing on the hospital site was destroyed by bombing. By 1924 the laboratories were in full swing and he continued work, started at the Medical Research Council's laboratory at Hampstead, on the physiology of plain muscle. In these studies Lovatt Evans was unable to detect any increase in oxygen consumption during tonic contraction, in fact the muscle used less oxygen than when relaxed which he attributed to the reduction in the surface of the fibres. (It had already been shown by Parnas and others that during the tonic contraction of the adductor muscles of bivalves there is no increase in the oxygen usage of the animals.) He found that lactic acid is formed, when the muscle is repeatedly stimulated in oxygen, at an accelerated rate when the tissue is deprived of oxygen, or immersed in a cyanide solution, and that there is a removal of lactic acid if the asphyxiated tissue is returned to oxygen. Only about one-third of the lactic acid was oxidized, the remainder being removed in some other form.

**Return to University College**

When in 1923 Starling retired from the Jodrell chair to take up a Foulerton Research Professorship of the Royal Society, he was succeeded by A. V. Hill, but remained in the Department in a suite of rooms provided out of a Rockefeller benefaction. In 1926 Hill relinquished the Jodrell chair and took up a second Foulerton Professorship and also repaired to a suite of rooms in the Department. Of these changes Hill wrote: 'It is not always easy, when appointed to be head of a scientific department, to inherit one's predecessor as well as his laboratory. When Charles Lovatt Evans came to the chair of physiology at University College in 1926 he had to put up with two of them, Ernest Starling and me. Starling died in 1927, but I remained in Evans's department during the whole of his term. Throughout those 23 years our relations were of the happiest kind, and he gave me and many of my colleagues continual wise and friendly help. I remember how, in 1928, he provided almost in a sentence the clue to a problem that had worried us for many years. Isolated muscles, however kindly treated, were apt to turn inexcitable for no apparent reason. They became excitable again at once if
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washed with Ringer's solution and Evans suggested that this was due to potassium leaking into the interspaces between the fibres. This was indeed the case; the conclusion, not only of practical importance in research, was a forerunner of much that followed in relation to the flow of potassium into and out of excitable tissues. His suggestion came from experience with smooth muscle.' This was the first time that Starling, A. V. Hill and Lovatt Evans found themselves in the same Department, but not the first time that they had an intimate scientific relationship. Just before the First World War, Patterson, Piper and Starling obtained evidence that the force of ventricular systole was determined by the diastolic length of the cardiac fibres—Starling's Law of the Heart. The work of Lovatt Evans on the oxygen usage of the heart had pointed in the same direction. Starling thought that perhaps this was a property common to all muscle and sent Lovatt Evans to Cambridge to study under A. V. Hill the relation between length of fibre in skeletal muscle and the heat produced on isometric contraction. Their results confirmed his expectation, including the fact that the heat production in skeletal muscle, like the force of systole and the oxygen usage of the heart reached a maximal value as stretching progressed, and then declined. This, Starling believed, was what happened in congestive heart failure.

Lovatt Evans had an enormous capacity for work. During the first five years or so of his tenure of the Jodrell chair he brought out a new edition of his *Recent advances in physiology*, which later he handed over to W. H. Newton, and undertook an even heavier task in editing Starling's *Principles of human physiology*; this he kept up to date over a period of 26 years, during which eight editions, a reprint, two Spanish and one Italian translation appeared. Concurrently with these activities he was engaged in investigating the conditions governing the lactic acid content of the blood (with Grace Eggleton) and the behaviour of liver glycogen in experimental animals (with Chiao Tsai & F. G. Young).

These studies led to the most important research of his career, on the carbohydrate metabolism of the dog's heart. It had long been recognized that glucose disappeared from the blood in a heart-lung preparation; it was presumed to be combusted by the heart and perhaps the lungs also (Patterson & Starling 1913) or converted into heart glycogen. The changes in blood lactic acid in such preparations had been little studied; but Anrep & Cannan (1923) had observed that in a heart-lung preparation the blood lactate rose and fell with blood pH when this was altered by ventilation of the lungs with air or oxygen/carbon dioxide. The origin and fate of the lactic acid could not be explained. In 1931 McGinty reported that the beating dog's heart appeared to take up lactic acid from the blood, judging by cardiac arterio-venous differences; and in a study which began a year later, Lovatt Evans and a team of several colleagues (he used to refer to this paper as 'Uncle Tom Cobley and all') set out to resolve the complex situation which evidently existed. They showed that in the dog heart-lung preparation blood glucose and lactate levels represented the balance between (a) usage of both...
by the heart, the latter in much greater amount than the former, and (b) the rate of conversion of blood glucose into lactic acid (glycolysis), which was influenced by blood pH as determined by the conditions of ventilation of the lungs. It was at first assumed that glycolysis took place in the blood alone; but Evans had noticed in earlier experiments with Grace Eggleton that lactate appeared more quickly in blood circulated through an isolated lung than in blood circulated through an artificial oxygenator similarly ventilated, and his attention was thus directed to the lung tissue itself as a site of active glycolysis, in addition to the blood. This was soon confirmed in an elegant study with Hsu & Kosaka (1934), and it completed the explanation of glucose and lactate changes in the dog heart-lung preparation; but it also indicated that in order to measure precisely and directly the glucose and lactate usage of the heart—a goal which Evans had now set himself—it would be necessary to replace the lungs by an artificial oxygenator and yet maintain the heart, isolated from the body, in good working condition for several hours. The technical problems were—and still are—formidable; to arrange separate artificial circulations for both sides of the heart, to achieve satisfactory oxygenation of the blood without frothing or damage, to avoid significant leakage of the defibrinated blood used in the circuit, to dispose of a vasoconstrictor substance (later shown to be serotonin) which appears in blood on defibrination and was lethal to an isolated heart, and (not least) to devise an operative procedure for removing the heart from the body and attaching it to the circuitry without interruption of its normal working. Success was achieved in the same year (1934) when with Grande & Hsu, he described two oxygenator circuits capable of maintaining the isolated dog's heart in an excellent working condition for several hours.

There followed a series of pioneer studies with pupils from several countries which provided unique information on the carbohydrate usage of the heart in relation to its conditions of work. The preferential usage of lactic acid compared with blood glucose was confirmed, particularly in presence of adrenaline, and it was found that pyruvic acid and beta-hydroxyacetic acid were also readily used. The heart glycogen was shown to constitute a store which could be called upon as blood lactate and glucose declined, or during partial anoxia, and was replenished from blood glucose but not lactate.

During the later years of this work, Lovatt Evans was increasingly distracted by calls upon his time from official sources concerned with the threat of war and cognisant of his earlier experience of gas warfare and protection from it; but nothing delighted and relaxed him more, depressed though he was by the march of events and his perception of the ultimate outcome, than to join his devoted team of pupils and work late into the evening with them on these arduous experiments, which made great demands on the skill and stamina of all concerned.

SECOND WORLD WAR

During the second war his services were once more required by the War
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Office and he worked at the Chemical Defence Experimental Establishment at Porton Down. With characteristic modesty the note he wrote for *Who's Who* merely states ‘National Service’ 1939-1944.

The imminence of war was recognized some time before it began, and in the University of London the Faculties did what they could to cope with the inevitable changes war would produce. Lovatt Evans, as Dean of the Preclinical Faculty, had made arrangements for the Faculty and male students to go to Cardiff, while female students and some staff members were to go to Sheffield. When war came these plans were put into operation. During the summer of 1940 the University contingents at Cardiff and Sheffield got homesick, and as Cardiff had been bombed, while Sheffield had not, they decided to return to London. They had just got back when the great ‘Blitz’ began, soon the College had its first hit, a land mine, which destroyed the Great Hall, the Physics Department, and a few other parts. A hurried search for quarters not too far away led to the acquisition of Badingham College in Leatherhead where a teaching centre was established by W. H. Newton heading physiology with Leonard Bayliss, Grace Eggleton, R. A. Gregory and D. H. Smyth; F. R. Winton and H. O. Schild took over pharmacology and Margaret Kerly biochemistry. The Professorial Board held several week-end meetings there and the students who lived in the College house used to murmur that they never saw an egg for weeks beforehand. Leonard Bayliss stayed only a short time as A. V. Hill caught him for work on anti-aircraft problems. In 1945 when the Department of Physiology returned to University College it occupied limited accommodation in their old quarters, the Admiralty retaining for a time the major area. Lovatt Evans occupied the operating room on the top floor of Pharmacology as his office with his secretary in the preparation room adjoining. It was from this office that he sketched the ruins of the College due to bombing, including the dome without its covering; the sketch is now in the College archives. During the years until his retirement he very largely spent his time getting the Department back to normal, and on committees. In his unselfish way he felt someone should do the committee work and it should be him, so as to allow more junior members of the Department correspondingly more time for their own research.

**Retirement and Porton, 1949-1968**

His retirement from the Jodrell Chair in 1949 was marked by a flood of ‘farewell dinners’ given to him by his many friends who wished to show their affection, admiration and esteem. Former members of his staff, at that time Professors, H. Barcroft, R. J. Brocklehurst, K. J. Franklin, G. P. Crowden, H. P. Gilding, R. A. Gregory, A. Hemingway, W. H. Newton, D. H. Smyth and F. G. Young, entertained him to dinner at The White Hart Hotel, Giltspur Street, on 22 April 1949. Other occasions included dinners given to him by University College—he had been Dean of the Faculty of Medicine for 13 years, by the Board of Studies of the University
of which he had been a member for 26 years acting for a time as Secretary and later as Chairman, by past and present members of the Department of Physiology, University College, and a farewell dance by the Students' Medical and Physiological Societies at University College Medical School. He was loath to give up experimental work and renewed as a consultant his association with the Chemical Defence Experimental Establishment at Porton Down where he was also given research facilities. He and his wife settled in Hedgemoor Cottage at Winterslow which was within travelling distance of Porton and only 17 miles from Romsey where his daughter Mrs Prince lived. He continued as a member of the Medical Research Council (1947-1950) and as chairman of the Military Personnel Research Committee (1948-1953), and became consultant to the War Office. He continued to take part in the affairs of the Research Defence Society. His Stephen Paget Memorial Lecture, delivered in 1949, was entitled 'Physiological research and the Antivivisection Act'. He had been a governor of the Royal Veterinary College since 1933, and in 1949-1963 served as chairman of Council. During this latter period the College became a School of the University and a site for a field station in Hertfordshire had been acquired. A new charter for the College was drafted in 1956. E. C. Amoroso wrote 'that he brought with him into the School those salient qualities of mind and character that were to stand him in good stead during a turbulent period in the College's history'. 'The wide sweep of his influence was also shown by the fact that from the outset he was the foremost and most effective advocate of the view, first, that really great veterinarians cannot be produced in an atmosphere that ignores the fundamental sciences upon which all veterinary medicine ultimately rests, and second, that neither effective scientists nor veterinarians can be created in an atmosphere which is not permeated by the background of disciplines that deal with human values, motivations, and experience'. In recognition of his services the College gave Evans the only honour at its disposal—the Fellowship of the Royal Veterinary College; he thus became the first and for the time being the only Fellow. What gave him great pleasure was the naming after him of the Sports Pavilion at the field station, and the picture of himself which he unveiled at the dedication of the physiological laboratories in his honour.

Research at Porton

Once more back at Porton Lovatt Evans quickly became immersed in examining the biological effects of the organic phosphorus compounds which were known to be potent inhibitors of cholinesterase. He, with a large team of workers, which included W. K. Berry, C. A. de Candole, W. W. Douglas, R. Holmes, K. E. V. Spencer, R. W. Torrance and K. M. Wilson studied the effect of six anti-cholinesterase compounds on nine animal species. They found that in all the species the picture was characteristic of the asphyxial state, and that failure of respiration was the predominant effect produced by intoxication with an anti-cholinesterase. An analysis of their results showed
that impaired ventilation occurred in three main ways, broncho-constriction, neuromuscular block and central respiratory failure. The central respiratory failure seemed to be the dominant factor in most instances, especially in the monkey. Neuromuscular block at the diaphragm could be severe in the rabbit, and broncho-constriction a marked feature in the cat. The depression of the activity of the respiratory centre they regarded as due to an action of the anticholinesterase within the central nervous system. They found that atropine could protect against the central inhibition and the broncho-constriction, and combined with artificial ventilation could maintain life in the presence of neuromuscular block.

Later, Lovatt Evans transferred his interest to the problem of sweating in the horse. This was stimulated by Col. Douglas F. G. Smith, R.A.V.C., who was then working at Porton. He reported that he had given a horse a dose of some 80 mg of atropine, and then cantered it well. He was expecting that sweating would have been suppressed. To his surprise the horse sweated normally. Lovatt Evans told him the horse was supposed to be an ‘adrenergic’ sweater since adrenaline injected by the subcutaneous or intravenous routes produced copious sweating. This fact had sometimes been interpreted to mean that the apocrine sweat glands in this species are supplied with sympathetic nerves which operate adrenergically, and are thus in contrast to the eccrine sweat glands in man and cat which are supplied with sympathetic nerves containing cholinergic secretory fibres. Lovatt Evans decided to test this hypothesis. He and D. F. G. Smith first confirmed that adrenaline given intravenously causes general sweating, and given intradermally causes sweating along narrow tracks often for 30-50 cm from the site of injection towards deeper lymphatics. On the other hand noradrenaline caused little or no sweating but resulted in pilo-erection along similar tracks; when given intravenously, a general pilo-erection occurred, but again no sweating. It had been known for many years that after section of the vago-sympathetic trunk, or excision of the guttural (anterior cervical) ganglion, spontaneous sweating of the head and upper neck on the same side set in after a variable interval of time, and continued for many hours. Lovatt Evans in conjunction with F. R. Bell, D. F. G. Smith and H. Weil-Malherbe added further observations in that the denervated area becomes warmer and sweats more readily than the rest of the body on exercise, or in response to adrenaline, locally or systemically, for several weeks or months. Furthermore, they found that when the cut sympathetic is stimulated electrically, sweating is not increased but is diminished or arrested, and the skin becomes paler and cooler. In the horse therefore the relation of sweating to the nerve supply is the opposite of that seen in eccrine glands, where resection of their nerve supply has no effect on secretion, and stimulation causes secretion. They were thus led to the proposition that the apocrine glands in the horse are not nerve-operated at all, but respond to endogenously released adrenaline. This view received support from experiments in which it was found that exercise in the horse such as to cause free sweating was accompanied by an
increase in the adrenaline content of the blood plasma. The sweating following sympathetic section in the neck was attributed to an increase in admission of the adrenaline already present in the blood.

These seemingly purely academic studies on the horse turned out to have considerable practical value. In the course of the investigation they found that after severe sweating had been produced by adrenaline administration in a normal horse, the area concerned became refractory to further doses of adrenaline, and remained so for days or weeks. This led them to wonder whether the excessive stimulation by prolonged exposure to hot wet climates might be the cause of dry coat in horses, a condition seen in a proportion of animals imported from temperate into hot wet climates, such as Malaya. The condition sets in slowly, and is preceded by profuse sweating, often while being shipped through the Red Sea, as they used to be. It is a serious condition in spirited thoroughbreds, race-horses and polo ponies, which sweat most easily as a rule. When affected animals are exercised the body temperature rises rapidly and greatly, and it subsides slowly. They run badly, and sometimes die on the course. Clearly a potential source of loss. As it was not possible for Lovatt Evans and Smith to go to Malaya they enticed collaborators there to join them, and they ran an investigation by remote control from Porton. R. S. T. Bowden in Ipoh and K. A. Ross in Penang were given instructions by letter as to procedure of experiments. Blood samples for the determination of blood adrenaline, adrenals and histological specimens of skin, all obtained from non-sweating, and from some normal horses in Malaya, were flown to Great Britain for examination. Their main conclusions were that the adrenaline content of the blood of horses in Malaya is significantly higher than that of horses in summer in England where such a level would cause sweating; dry-coat horses are less sensitive to adrenaline than are free sweaters, and the condition of anhidrosis can be precipitated or aggravated by intravenous adrenaline. Thus they regarded dry coat as a consequence of prolonged stimulation of the sweat glands by adrenaline, secreted as a response to conditions of hot moist climate.

The outcome of these findings was the construction of an air-conditioned stable in which the incoming air was first cooled to remove water-vapour, and then warmed to a suitable temperature, by which the humidity was lowered. The considerable cost was defrayed by the Straits Racing Association. One of the early results was with a horse which had been dry for 3 years. After 2 weeks in the chamber he showed responses to adrenaline and was put into a race which he ran well. At this juncture, Malaya became independent and the investigations lapsed.

Dr F. W. Beswick, Dr R. W. Brimblecombe and Miss June Stratton contributed the following appreciation: ‘Lovatt Evans had many friends at Porton and it would, no doubt, give him much pleasure to know that his portrait now hangs in the Mess, constant reminder to many people of pleasant and amusing talks at lunchtime about physiology, gardening,
Charles Arthur Lovatt Evans

politics, or indeed almost anything. On his 80th birthday a precedent was created by making him an honorary member of the Mess. Previously this honour has been reserved for distinguished members on their retirement. He will always be remembered by his Porton friends because of his consideration for their difficulties, both personal and professional, at all times. Those of us who were involved with him in making decisions of policy appreciated how he always tried to understand the other man’s point of view.

‘His advice upon scientific matters, and indeed upon almost any topic, was frequently sought and freely given, but he did not confine his activities to this consultant role and he was active in the laboratory until early in 1968. He would not delegate responsibilities for his experiments; he clearly enjoyed the practical manipulations involved and in most cases worked with the minimum amount of assistance from a technician. His last published piece of work, in 1967, was concerned with the toxicity of hydrogen sulphide and other sulphides and, he not only did the animal work himself, cannulating six different blood vessels, but he also carried out the iodine titrations necessary to estimate the sulphide content of the solutions he was to inject. Earlier he had returned to an old interest of his, the treatment of hydrocyanic acid poisoning but, in the main, his work at Porton was in two main fields. In a series of papers during the 1950s he, with various collaborators, investigated mechanisms of sweating in horses. He always alleged, not very accurately, that in this project his main role was to collect data from his co-workers who were widely scattered, one of them coming from as far afield as Malaya. In addition, with various colleagues at Porton he worked on the mode of action of organophosphorus anticholinesterase and of drugs which would antagonize their effects. Although he liked to work mainly on his own, when technical assistance was necessary he made even the most junior technicians feel at ease and was most generous in acknowledging their contributions to the project. All the technicians who were associated with him still remember him with great affection and gratitude for the interest he took in their careers and personal well-being. His attitude towards the Civil Service was one of amused tolerance and although the mechanisms of its operation and finances were always, he said, beyond him, he nevertheless never used his position to obtain preferential treatment.’

Family

In 1911, the year Lovatt Evans became Sharpey Scholar at University College, he married Laura Stevenson whose home was in Hanley, Stoke-on-Trent. She possessed a beautiful mezzo-soprano voice, and her father, an operatic singer, had been given the name ‘the silver-toned tenor’. Lovatt Evans and his wife lived in The Vale, Golders Green, and after a short stay at Farnham during the war returned to London to live at 57 Ashbourne Avenue. When he became Jodrell Professor they moved to 47 Hampstead Way where they kept open house for their many friends at home and abroad. Their elder daughter, Joan, Mrs Peter Prince, was until recently Director of
the Romsey Division of the Red Cross, and is at present in charge of all the Welfare Services in the Romsey region. The Princes have one daughter, Gillian, who trained as a nurse at University College Hospital, spent some time as an air hostess with British European Airways and after two years in Johannesburg acting as Sister Receptionist to a consultant physician and his wife, is now acting as medical secretary to a London doctor. The Evanses' younger daughter Yvonne was in Copenhagen at the beginning of the Second World War and there married Jørgen Schou. She is now taking a degree course in philosophy and psychology at the University of Copenhagen. The Schous have one son and three daughters. Their eldest daughter, Joan, is married to a surgeon, Baron Niels Erik Brahe, who is a descendant of Tycho Brahe. The Brahes have one son and two daughters.

**Personalities**

Lovatt Evans had an amazing capacity for making friends of all ages and in all walks of life. This was because he was really interested in people and in their way of life, and they in their turn responded to his obvious kindliness and sincerity. He inspired trust. His particular interest in giving help to deserving youngsters during their early struggles was no doubt born of his own arduous days in his youth when in Birmingham; yet help was only forthcoming after they had proved themselves. He once remarked: ‘When I began, the road to academic success was by no means smooth and signposted as it is now. I sailed my own frail barque on uncharted waters. The lesson I learnt from all this was that the more that is done for one the less one does for oneself. When I came to be head of a department I put this into practice by exposing most of my staff to a course of studied neglect. If they had feet of their own, they stood on them, and got credit accordingly. Surprisingly few proved to have no feet.’

He was an omnivorous reader with a remarkable memory for quotations from the Bible, Shakespeare, the ancient philosophers, Dr Johnson, Omar Khayam, Bernard Shaw, Gilbert and Sullivan usually with some reference to science. His vacations were not infrequently spent in visiting museums and art galleries, in hiking or camping with his family. A gifted raconteur, those who knew him well recognized the quizzical expression and twinkle in his eyes which heralded the build up of the characters and environment of an anecdote, many of which were directed against himself. All had a background of humour as illustrated by his delight in recalling an episode which occurred when, in 1963, he was rushed to hospital with a gastric haemorrhage. ‘A friend rang up to ask how I was getting on. The receptionist said they had nobody of my name in any ward, after a pause she added: “Wait a moment.” A male voice came on the line and enquired: “Do you mean the physiologist?” and then “Good heavens, is he still alive?”’

As a lecturer to students he was brilliant. He gave four lectures a week to
the Junior class; these covered blood, heart, circulation, respiration, digestion, and muscle. For each one, the long bench in the lecture theatre was loaded with apparatus; and as he spoke he performed experiments to illustrate his account. His knowledge of the history and personalities of physiology was encyclopaedic and a topic under discussion did not originate, as it did for most, with some paper of five or ten years before; he would place it against the background of history, recalling some obscure finding of Magendie, Heidenhain, or Claude Bernard to lend force to his argument. M. de Burgh Daly recalls that one of the impressive demonstrations which Lovatt Evans used to perform annually to the students was the physiology of the heart using Starling’s heart-lung preparation. He always set up the preparation in the classical way with defibrinated blood rather than with blood containing an anti-coagulant. The last demonstration he gave at University College before he retired from the Jodrell Chair was performed before a full ‘house’ and was not without some light-hearted moments. At one stage he turned his back on the heart-lung preparation to write on the blackboard in order to amplify a point he was trying to make and, as he did so, a small blood vessel, which must have spontaneously ruptured unnoticed a moment or two earlier, sprayed the back of his white coat, thus producing to the delight of the spectators, but unknown to him, a classical contour of an arterial pressure wave.

As an examiner he rarely left the candidate dissatisfied. Some 40 years ago, when accumulators and induction coils were used for stimulating muscles and nerves, and it was a popular pastime to construct one’s own ‘wireless’ set, he approached a candidate in a practical physiology examination and carefully observed a dried-up frog gastrocnemius sciatic nerve preparation and the stimulation apparatus, both being almost obscured by a festoon of wires arising to a height of nearly one foot above the bench. He smiled at the candidate—a cheerful Oriental—who smiled back, and then put his hand on the candidate’s shoulder and inquired kindly: ‘Tell me, how many radio stations can you get on this hook-up?’ The candidate, well aware of his shortcomings, seemed delighted that no further comments were forthcoming and, smiling, bowed as Lovatt Evans left.

He was not averse to experimenting upon himself and on one such occasion wishing to demonstrate the blush produced by the inhalation of amyl nitrate in front of a class he ignominiously fainted from a drop in blood pressure. He once said that ‘experiment is monkeying about with conditions to see what happens, which is probably why boys take so well to science, and why many scientists are so boyish in their outlook’. He himself certainly had a delightfully boyish outlook in some ways. One of his hobbies was painting in water colours, many of scenes in Devon and Cornwall done when on holiday, a few of scenes around Birmingham. When 12 years old he had passed with credit an examination in drawing at his Elementary School, so he had had some training. On hiking expeditions he enjoyed talking to local people on country matters and so add to his already considerable knowledge.
of the countryside. In later years while living at Winterslow he would
sometimes call for his daughter, Joan, at the Red Cross Office in Romsey
and would wander into the kitchen to talk to the helpers, or into the Club
Room to yarn with the old folk and the disabled. As one of his staff remarked:
'From the highest to the lowest he treated them all the same.'

When his wife became ill in 1958 and ultimately bedridden he looked after
her with incredible patience and affection. After she died in 1964 he con­
tinued to live alone in Hedgemoor Cottage where his daughter Joan would
periodically stay the week-end with him. He also enjoyed visits to see Yvonne
in Copenhagen from time to time. At home he tended his garden with loving
care, and in the evenings improved his French by listening to the radio, and
he also started to learn Italian. Early in 1968 after he had suffered a stroke
he stayed at his daughter’s home in Romsey and for a short time lived in the
Officers’ Mess at Porton. His memory for past events was almost unimpaired
and he enjoyed visits from his many friends and took a special pleasure in
recalling all the humorous episodes of his past life. But he was never quite
free from pain which he bore with great courage. He was insistent on ending
his days in his cottage where he died a few weeks after his return there in
August.

Lovatt Evans was Sharpey-Schafer lecturer (University of Edinburgh,
1939), Louis Abrahams lecturer (Royal College of Physicians of London,
1946), Stephen Paget lecturer (Research Defence Society, 1949), first
Bayliss-Starling lecturer (Physiological Society, 1963), and William Dick
Memorial lecturer (Edinburgh, 1965). He was an honorary member of the
Physiological Society, the Biochemical Society, the Italian Society of
Experimental Biology, the Ergonomics Society of which he was a founder
member, and a foreign member of the Royal Physiological Society, Lund.
He was a Fellow of University College London, and of the Royal Veterinary
College, London. In 1934 he received the LL.D. from the University of
Birmingham, and in 1957 the LL.D. from the University of London. He was
knighted in 1951.

His ashes and those of his wife rest beneath a beech tree in Winterslow
cemetery. Alongside is a natural boulder of Danish granite, engraved with
their names, which was brought from Denmark by his daughter, Yvonne. The
bas relief, sculptured by Mr Michael Gillespie, on the wall inside the entrance
to the Physiology Department at University College London, was donated
by his two daughters.

Lovatt Evans did not leave any Personal Notes with the Royal Society
because he felt that the preparation of an obituary notice ‘would cause need­
less trouble to others, and that the notice would be of no particular interest
to anyone’. It is astonishing that one with his capacity for making friends
could not believe that when his life was over there would be many who would
regard the privilege of writing about him as a labour of love and not as an
imposition. But his family and intimate friends knew that he held this belief
in all sincerity which was one due to his innate modesty and an aversion to
imposing upon others. Among the papers found amongst his effects were records of his early examination successes and notes of speeches, on formal occasions and on his retirement, from which we have drawn freely. More important still we gratefully acknowledge the great help we have received from his daughters Mrs Peter Prince and Mrs Lovatt Schou, also from his many friends including Professor E. C. Amoroso, F.R.S., Dr F. W. Beswick, Dr R. W. Brimblecombe, Professor M. de Burgh Daly, Dr Grace Eggleton, Professor A. V. Hill, F.R.S., Professor H. D. Kay, F.R.S., Dr W. S. S. Ladell, Dr H. E. Lewis, Sir Rudolph Peters, F.R.S., Miss June Stratton and Professor F. R. Winton.

The photograph reproduced with this memoir is by Dr H. E. Lewis.

I. de Burgh Daly
R. A. Gregory

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